IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of: Bruno De Man	§	Group Art Unit:	2624
Serial No.: 10/731,356	§	Examiner:	Chu, Randolph I.
Filed: December 9, 2003	§	Confirmation No.:	4382
For: METHOD AND APPARATUS FOR THE REDUCTION OF ARTIFACTS IN COMPUTED TOMOGRAPHY IMAGES	§	Atty. Docket:	133642-1/YOD/SIN GERD:0068

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April 23, 2008	/Patrick S. Yoder/
Date	Patrick S. Yoder

APPEAL BRIEF PURSUANT TO 37 C.F.R. §§ 41.31 AND 41.37

This Appeal Brief is being filed in furtherance to the Notice of Appeal filed electronically on January 25, 2008.

The Commissioner is authorized to charge the requisite fee of $510.00, and any additional fees which may be required, to Deposit Account No. 07-0868; Order No. 133642-1/YOD (GERD:0068).

Appellant hereby requests a one (1) month extension in the statutory period for submission of the Appeal Brief, from March 25, 2008 to April 25, 2008, in accordance with 37 C.F.R. § 1.136. The Commissioner is authorized to charge the requisite fee of $120.00, and any other fee that may be required, to Deposit Account No. 07-0868; Order No. 133642-1/YOD (GERD:0068).

1. **REAL PARTY IN INTEREST**

The real party in interest is General Electric Company, the Assignee of the above-referenced application by virtue of the Assignment to General Electric Company, by Bruno De Man recorded at reel 014785, frame 0288, and dated December 9, 2003. Accordingly, General Electric Company, as the parent company of the Assignee of the above-referenced application, will be directly affected by the Board's decision in the pending appeal.

2. **RELATED APPEALS AND INTERFERENCES**

Appellant is unaware of any other appeals or interferences related to this Appeal. The undersigned is Appellant's legal representative in this Appeal.

3. **STATUS OF CLAIMS**

Claims 1, 2, 7-13, 18, 19, 21, and 22 are currently pending, are currently under final rejection and, thus, are the subject of this Appeal. Claims 14-17 and 20 were previously canceled by Appellant. Claims 3-6 are currently objected to as being dependent on rejected base claims but are also indicated as allowable if rewritten in independent form.

4. **STATUS OF AMENDMENTS**

All amendments in relation to the claims of the present patent application have been entered, and no amendments have been submitted or entered subsequent to the Final Office Action mailed on October 25, 2007.

5. **SUMMARY OF CLAIMED SUBJECT MATTER**

The invention relates generally to the field of image reconstruction in computed tomography (CT) systems. *See, e.g.,* Application, page 1, lines 2-3. More particularly, the invention relates to a method and apparatus for reducing artifacts in image data generated by computed tomography systems. *See, e.g., id.*, page 1, lines 3-4.

The Application contains five independent claims, namely, claims 1, 18, 19, 21, and 22, all of which are the subject of this Appeal. The subject matter of these claims is summarized below.

With regard to the aspect of the invention set forth in independent claim 1, discussions of the recited features of claim 1 can be found at least in the below cited locations of the specifications and drawings. By way of example, an embodiment in accordance with claim 1 relates to a method for reducing artifacts in image data generated by a computed tomography system (*e.g.,* 10). The artifacts are due to the presence of a high density object (*e.g.,* 68) in a subject of interest (*e.g.,* 18). *See, e.g., id.,* page 9, lines 19-29; figures 1-3. The method includes receiving measured sinogram data from the computed tomography system (*e.g.,* step 84). *See, e.g., id.,* page 12, lines 6-7; figure 7. The sinogram data is representative of a plurality of measured sinogram elements. *See, e.g., id.,* page 10, lines 7-8; figure 4. The method also includes reconstructing the measured sinogram data to generate initial reconstructed image data (*e.g.,* step 86). *See, e.g., id.,* page 10, lines 11-13; page 10, line 27 – page 11, line 8; page 12, lines 8-11; figures 5 and 7. In addition, the method includes identifying a trace of the high density object (*e.g.,* 68) in the measured sinogram data (*e.g.,* step 88). *See, e.g., id.,* page 11, lines 10-18; page 12, lines 13-29; figures 5 and 7. Further, the method includes identifying a region of interest (*e.g.,* 78) in the initial reconstructed image data (*e.g.,* step 90). *See, e.g., id.,* page 11, line 22 – page 12, line 2; page 13, lines 1-14; figures 6 and 7. The method also includes identifying an optimization criterion based upon the region of interest (*e.g.,* 78), in an image domain (*e.g.,* step 92). *See, e.g., id.,* page 13, line 16 – page 14, line 5; figure 7. The method further includes iteratively adjusting the measured sinogram elements at least in the trace of the high density object (*e.g.,* 68) in the measured sinogram data based upon the optimization criterion in the image domain, to generate corrected sinogram data (*e.g.,* step 94). *See, e.g., id.,* page 14, lines 7-12; figure 7. In addition, the method includes reconstructing the corrected sinogram data to generate improved reconstructed image data (*e.g.,* step 96). *See, e.g., id.,* page 14, lines 14-17; figure 7.

With regard to the aspect of the invention set forth in independent claim 18, discussions of the recited features of claim 18 can be found at least in the below cited locations of the specifications and drawings. By way of example, an embodiment in accordance with claim 18 relates to a computed tomography system (*e.g.,* 10) for reducing artifacts in image data. The artifacts are due to the presence of a high density object (*e.g.,* 68) in a subject of interest (*e.g.,* 18). *See, e.g., id.,* page 9, lines 19-29; figures 1-3. The computed tomography system (*e.g.,* 10) includes an x-ray source (*e.g.,* 12) configured to project an x-ray beam (*e.g.,* 16, 20) from a plurality of positions through the subject of interest (*e.g.,* 18). *See, e.g., id.,* page 5, lines 2-15; page 5, line 30 – page 6, line 7; page 7, line 26 – page 8, line 17; figures 1 and 2. The computed tomography system (*e.g.,* 10) also includes a detector (*e.g.,* 22) configured to produce a plurality of electrical signals corresponding to the x-ray beam (*e.g.,* 16, 20). *See, e.g., id.,* page 5, lines 10-28; page 8, lines 4-9; figures 1 and 2. In addition, the computed tomography system (*e.g.,* 10) includes a processor (*e.g.,* 36) configured to process the plurality of electrical signals. *See, e.g., id.,* page 6, line 23 – page 7, line 2; page 8, line 19 – page 9, line 2; figures 1 and 2. The processing of the plurality of electrical signals is done to generate measured sinogram data. *See, e.g., id.,* page 10, lines 2-7; figure 4. The sinogram data is representative of a plurality of measured sinogram elements. *See, e.g., id.,* page 10, lines 7-8; figure 4. The processor (*e.g.,* 36) is further configured to reconstruct the measured sinogram data to generate initial reconstructed image data (*e.g.,* step 86). *See, e.g., id.,* page 10, lines 11-13; page 10, line 27 – page 11, line 8; page 12, lines 8-11; figures 5 and 7. The processing of the plurality of electrical signals may also identify a trace of the high density object (*e.g.,* 68) in the measured sinogram data (*e.g.,* step 88). *See, e.g., id.,* page 11, lines 10-18; page 12, lines 13-29; figures 5 and 7. In addition, the processing of the plurality of electrical signals may identify a region of interest (*e.g.,* 78) in the initial reconstructed image data (*e.g.,* step 90). *See, e.g., id.,* page 11, line 22 – page 12, line 2; page 13, lines 1-14; figures 6 and 7. The processing of the plurality of electrical signals may further identify an optimization criterion based upon the region of interest (*e.g.,* 78), in an image domain (*e.g.,* step 92). *See, e.g., id.,* page 13, line 16 – page 14, line 5; figure 7. The processing of the plurality of electrical signals

may also iteratively adjust the measured sinogram elements at least in the trace of the high density object (*e.g.,* 68) in the measured sinogram based upon the optimization criterion in the image domain, to generate corrected sinogram data (*e.g.,* step 94). *See, e.g., id.,* page 14, lines 7-12; figure 7. In addition, the processing of the plurality of electrical signals may reconstruct the corrected sinogram data to generate improved reconstructed image data (*e.g.,* step 96). *See, e.g., id.,* page 14, lines 14-17; figure 7.

With regard to the aspect of the invention set forth in independent claim 19, discussions of the recited features of claim 19 can be found at least in the below cited locations of the specifications and drawings. By way of example, an embodiment in accordance with claim 19 relates to at least one computer-readable medium storing computer instructions for instructing a computer system to reduce artifacts in image data generated by a computed tomography system (*e.g.,* 10). The artifacts are due to the presence of a high density object (*e.g.,* 68) in a subject of interest (*e.g.,* 18). *See, e.g., id.,* page 9, lines 19-29; figures 1-3. The computer instructions include receiving measured sinogram data from the computed tomography system (*e.g.,* step 84). *See, e.g., id.,* page 12, lines 6-7; figure 7. The sinogram data is representative of a plurality of measured sinogram elements. *See, e.g., id.,* page 10, lines 7-8; figure 4. The computer instructions also include reconstructing the measured sinogram data to generate initial reconstructed image data (*e.g.,* step 86). *See, e.g., id.,* page 10, lines 11-13; page 10, line 27 – page 11, line 8; page 12, lines 8-11; figures 5 and 7. The computer instructions further include identifying a trace of the high density object (*e.g.,* 68) in the measured sinogram data (*e.g.,* step 88). *See, e.g., id.,* page 11, lines 10-18; page 12, lines 13-29; figures 5 and 7. In addition, the computer instructions include identifying a region of interest (*e.g.,* 78) in the initial reconstructed image data (*e.g.,* step 90). *See, e.g., id.,* page 11, line 22 – page 12, line 2; page 13, lines 1-14; figures 6 and 7. The computer instructions also include identifying an optimization criterion based upon the region of interest (*e.g.,* 78), in an image domain (*e.g.,* step 92). *See, e.g., id.,* page 13, line 16 – page 14, line 5; figure 7. Further, the computer instructions include iteratively adjusting the measured sinogram elements at least in the trace of the high density object (*e.g.,* 68) in the measured

sinogram data based upon the optimization criterion in the image domain, to generate corrected sinogram data (*e.g.,* step 94). *See, e.g., id.,* page 14, lines 7-12; figure 7. The computer instructions also include reconstructing the corrected sinogram data to generate improved reconstructed image data (*e.g.,* step 96). *See, e.g., id.,* page 14, lines 14-17; figure 7.

With regard to the aspect of the invention set forth in independent claim 21, discussions of the recited features of claim 21 can be found at least in the below cited locations of the specifications and drawings. By way of example, an embodiment in accordance with claim 21 relates to a computed tomography system (*e.g.,* 10) for reducing artifacts in image data. The artifacts are due to the presence of a high density object (*e.g.,* 68) in a subject of interest (*e.g.,* 18). *See, e.g., id.,* page 9, lines 19-29; figures 1-3. The system includes a means for processing a plurality of electrical signals corresponding to an x-ray beam (*e.g.,* 16, 20) generated by the computed tomography system (*e.g.,* 10) to generate measured sinogram data. *See, e.g., id.,* page 6, line 23 – page 7, line 2; page 8, line 19 – page 9, line 2; figures 1 and 2. The means for processing may, for instance, be a processor (*e.g.,* 36). *Id.* The sinogram data is representative of a plurality of measured sinogram elements. *See, e.g., id.,* page 10, lines 7-8; figure 4. The processing further includes reconstructing the measured sinogram data to generate initial reconstructed image data (*e.g.,* step 86). *See, e.g., id.,* page 10, lines 11-13; page 10, line 27 – page 11, line 8; page 12, lines 8-11; figures 5 and 7. The processing may also identify a trace of the high density object (*e.g.,* 68) in the measured sinogram data (*e.g.,* step 88). *See, e.g., id.,* page 11, lines 10-18; page 12, lines 13-29; figures 5 and 7. The processing may further identify a region of interest (*e.g.,* 78) in the initial reconstructed image data (*e.g.,* step 90). *See, e.g., id.,* page 11, line 22 – page 12, line 2; page 13, lines 1-14; figures 6 and 7. In addition, the processing may identify an optimization criterion based upon the region of interest (*e.g.,* 78), in an image domain (*e.g.,* step 92). *See, e.g., id.,* page 13, line 16 – page 14, line 5; figure 7. Further, the processing may iteratively adjust the measured sinogram elements at least in the trace of the high density object (*e.g.,* 68) in the measured sinogram data based upon the optimization criterion in the

image domain, to generate corrected sinogram data (*e.g.,* step 94). *See, e.g., id.,* page 14, lines 7-12; figure 7. The processing may also reconstruct the corrected sinogram data to generate improved reconstructed image data (*e.g.,* step 96). *See, e.g., id.,* page 14, lines 14-17; figure 7.

With regard to the aspect of the invention set forth in independent claim 22, discussions of the recited features of claim 22 can be found at least in the below cited locations of the specifications and drawings. By way of example, an embodiment in accordance with claim 22 relates to a method for reducing artifacts in image data generated by a computed tomography system (*e.g.,* 10). The artifacts are due to the presence of objects in a subject of interest (*e.g.,* 18). *See, e.g., id.,* page 9, lines 19-29; figures 1-3. The method includes receiving measured sinogram data from the computed tomography system (*e.g.,* step 84). *See, e.g., id.,* page 12, lines 6-7; figure 7. The sinogram data is representative of a plurality of measured sinogram elements. *See, e.g., id.,* page 10, lines 7-8; figure 4. The method also includes reconstructing the measured sinogram data to generate initial reconstructed image data (*e.g.,* step 86). *See, e.g., id.,* page 10, lines 11-13; page 10, line 27 – page 11, line 8; page 12, lines 8-11; figures 5 and 7. The method further includes identifying a sinogram region of interest (*e.g.,* 78) in the measured sinogram data (*e.g.,* step 90). *See, e.g., id.,* page 11, line 22 – page 12, line 2; page 13, lines 1-14; figures 6 and 7. In addition, the method includes identifying an image region of interest (*e.g.,* 78) in the initial reconstructed image data. *Id.* Further, the method includes identifying an optimization criterion based upon the image region of interest (*e.g.,* 78), in an image domain (*e.g.,* step 92). *See, e.g., id.,* page 13, line 16 – page 14, line 5; figure 7. The method also includes iteratively adjusting the measured sinogram elements in at least the sinogram region of interest (*e.g.,* 78) based upon the optimization criterion in the image domain, to generate corrected sinogram data (*e.g.,* step 94). *See, e.g., id.,* page 14, lines 7-12; figure 7. In addition, the method includes reconstructing the corrected sinogram data to generate improved reconstructed image data (*e.g.,* step 96). *See, e.g., id.,* page 14, lines 14-17; figure 7.

A benefit of the invention, as recited in these claims, is that the *measured* sinogram data is iteratively adjusted based upon the optimization criterion. The adjustment may be based on a reliability measure associated with each sinogram element. Defining the optimization criterion enables the identified region of interest in the initial reconstructed image data to attain specific attenuation values, uniform attenuation values, or minimum angular variations. The resulting corrected sinogram data, when reconstructed, results in improved reconstructed image data with reduced artifacts.

This is a clear difference and distinction from the prior art, as discussed below.

6. GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

First Ground of Rejection for Review on Appeal:

Whether the Examiner satisfied the burden of establishing that claims 1, 2, 10-13, 18, 19, 21, and 22 are anticipated under 35 U.S.C. § 102(b) by Bruno De Man, "Iterative Reconstruction for Reduction of Metal Artifacts in Computed Tomography," PhD thesis, University of Leuven, 2001 (hereinafter "De Man").

Second Ground of Rejection for Review on Appeal:

Whether the Examiner satisfied the burden of establishing that, under 35 U.S.C. § 103(a), claim 7 is obvious over De Man in view of Hsieh (U.S. Patent 6,385,278, hereinafter "Hsieh").

Third Ground of Rejection for Review on Appeal:

Whether the Examiner satisfied the burden of establishing that, under 35 U.S.C. § 103(a), claim 8 is obvious over De Man in view of Luo (U.S. Patent Application Publication 2004/0001569, hereinafter "Luo").

Fourth Ground of Rejection for Review on Appeal:

Whether the Examiner satisfied the burden of establishing that, under 35 U.S.C. § 103(a), claim 9 is obvious over De Man in view of Karimi et al. (U.S. Patent 6,813,374, hereinafter "Karimi").

7. ARGUMENT

As discussed in detail below, the Examiner has improperly rejected the pending claims. Further, the Examiner has misapplied long-standing and binding legal precedents and principles in rejecting the claims under Sections 102 and 103. Accordingly, Appellant respectfully requests full and favorable consideration by the Board, as Appellant strongly believes that claims 1, 2, 7-13, 18, 19, 21, and 22 are currently in condition for allowance.

A. Ground of Rejection No. 1:

The Examiner rejected claims 1, 2, 10-13, 18, 19, 21, and 22 under 35 U.S.C. § 102(b) as being unpatentable over De Man. Of these, claims 1, 18, 19, 21, and 22 are independent. Because De Man fails to disclose or suggest each and every element of the instant claims, Appellant respectfully requests that the Board review and reverse the improper rejection of these claims.

1. Judicial precedent has clearly established a legal standard for a *prima facie* anticipation rejection.

Anticipation under section 102 can be found only if a single reference shows exactly what is claimed. *Titanium Metals Corp. v. Banner*, 778 F.2d 775, 227 U.S.P.Q. 773 (Fed. Cir. 1985). For a prior art reference to anticipate under section 102, every element of the claimed invention must be identically shown in a single reference. *In re Bond*, 910 F.2d 831, 15 U.S.P.Q.2d 1566 (Fed. Cir. 1990). To maintain a proper rejection under section 102, a single reference must teach each and every limitation of the rejected claim. *Atlas Powder v. E.I. du Pont*, 750 F.2d 1569 (Fed. Cir. 1984). The prior art reference also must show the *identical* invention "*in as complete detail as contained*

in the ... claim" to support a *prima facie* case of anticipation. *Richardson v. Suzuki Motor Co.*, 868 F.2d 1226, 1236, 9 U.S.P.Q. 2d 1913, 1920 (Fed. Cir. 1989). Accordingly, Appellant need only point to a single element not found in the cited reference to demonstrate that the cited reference fails to anticipate the claimed subject matter.

2. **The Examiner's rejection of claims 1, 2, 10-13, 18, 19, 21, and 22 is improper because the rejection fails to establish a *prima facie* case of anticipation.**

Appellant respectfully submits that the rejection of claims 1, 2, 10-13, 18, 19, 21, and 22 under 35 U.S.C. § 102(b) as being anticipated by De Man is improper because the cited reference fails to disclose each and every element recited by the claims. For instance, independent claim 1, which is believed to be representative of this group of claims, recites "*identifying an optimization criterion* based upon the region of interest, *in an image domain*" and "*iteratively adjusting the measured sinogram elements* at least in the trace of the high density object in the measured sinogram data *based upon the optimization criterion in the image domain*, to generate corrected sinogram data" (emphasis added). Because De Man fails to disclose these elements, the cited reference cannot support a *prima facie* case of anticipation with respect to claims 1, 2, 10-13, 18, 19, 21, and 22.

Appellant believes that a short discussion of the operation of an exemplary embodiment of the present invention will be helpful to the Board and the Examiner in the present case. Accordingly, the following discussion of an exemplary embodiment of the disclosed system is provided merely for the sake of clarity and understanding. Measured sinogram data representative of a plurality of sinogram elements is received from a computed tomography (CT) system (*e.g.*, step 84). *See, e.g.*, Application, page 12, lines 6-8; figure 7. This measured sinogram data is reconstructed to generate initial reconstructed image data (*e.g.*, step 86). *See, e.g., id.*, page 12, lines 8-11; figure 7. Next, a trace of a high density object is identified in the measured sinogram data and a region of interest is

identified in the initial reconstructed image data (*e.g.*, steps 88 and 90). *See, e.g., id.*, page 12, line 13 – page 13, line 14; figure 7. Then, an *optimization criterion is identified* based upon the region of interest *in an image domain* (*e.g.*, step 92). *See, e.g., id.*, page 13, line 16 – page 14, line 5; figure 7. For instance, the optimization criterion may include determining an optimal attenuation value associated with the region of interest, determining an optimal uniformity value associated with the region of interest, or minimizing angular variations associated with the region of interest based on the relative position of the region of interest with respect to the high density object. *Id.* It is important to note that all of these optimization criteria are in the *image domain*, as opposed to being in the *sinogram domain.* The *measured sinogram elements are iteratively adjusted* at least in the trace of the high density object in the measured sinogram data *based upon the optimization criterion in the image domain*, to generate corrected sinogram data (*e.g.*, step 94). *See, e.g., id.*, page 14, lines 7-12; figure 7. For instance, the measured sinogram data may be iteratively adjusted based upon a reliability measure assigned to each sinogram element in the measured sinogram data, wherein the sinogram elements are adjusted in proportion to their reliability measures. *Id.* The corrected sinogram data is reconstructed to generate improved reconstructed image data (*e.g.*, step 96). *See, e.g., id.*, page 14, lines 14-17; figure 7.

De Man is a thesis, written by the sole inventor himself, directed to the study of metal artifacts in CT images. In particular, De Man is directed to the reduction of metal artifacts in CT images using iterative reconstruction techniques. In contrast to the present application, De Man discloses obtaining a first estimate (p'_{is}) by sub-sampling the measured sinogram data (p_i) using bilinear interpolation (*e.g.*, step 1). *See, e.g.*, De Man, page 108. Then, the first estimate (p'_{is}) is rebinned ($\hat{p}_i$) by intensity-averaging the corresponding pixels (*e.g.*, step 2). *See, e.g., id.* Then, an error (Δp_{is}) between the measured sinogram (p_i) and the rebinned values ($\hat{p}_i$) is calculated and sub-sampled using bilinear interpolation

(*e.g.,* step 3). *See, e.g., id.* Next, the error is added to the current estimate (p'_{is}) over a number of iterations resulting in a corrected sinogram ($\overline{p}_i$) (*e.g.,* steps 4-5). *See, e.g., id.*

Appellant submits that this section of De Man does not disclose "*identifying an optimization criterion* based upon the region of interest, *in an image domain*" or "*iteratively adjusting the measured sinogram elements* at least in the trace of the high density object in the measured sinogram data *based upon the optimization criterion in the image domain*, to generate corrected sinogram data" (emphasis added). Instead, this section merely discloses an iterative approach/algorithm for *estimating* measured sinogram data. In this approach, an estimate of the measured sinogram elements is obtained by *sub-sampling* the measured sinogram. However, the *measured sinogram* is not *iteratively adjusted*, as recited in the claimed subject matter.

Further, steps 3-5 discussed in this section only disclose that the algorithm is performed for a number of iterations after which the measured sinogram is rebinned to provide a corrected sinogram. Specifically, even if the algorithm disclosed in De Man is performed for a number of iterations, the specific number of iterations that would need to be performed is determined by defining a stopping criterion, in the sinogram domain (*e.g.,* an error with respect to the *sinogram* data). In other words, the approach/algorithm disclosed in De Man for estimating the measured sinogram data actually simply uses a *stopping criterion in the measured sinogram domain*, and not an *optimization criterion in an image domain*.

Appellant offers, in support of this position, an affidavit originally filed with a response of December 26, 2007 to the Final Office Action in which he, the sole inventor of the presently claimed invention, and author of the De Man reference, further attests to this distinction between his previous work and the claimed subject matter.

In an Advisory Action mailed on January 30, 2008, the Examiner disagreed with Appellant's contentions stating that "[t]he claim states 'optimization criterion' but does not limits [sic] to the criterion. De Man correct [sic] the sinogram by number of iteration of calculating sub-sampled error and rebinned. Sub-sampled error which read on the claims broad limitation of 'criterion'. Also, Stopping [sic] criterion mentioned by applicant can read on broad limitation of 'optimization criterion'." Advisory Action mailed January 30, 2008, page 2. Appellant reiterates that the correction disclosed in De Man is based on a stopping criterion in the *sinogram domain*. Specifically, the stopping criterion is based on an error between the measured sinogram (p_i) and the rebinned values ($\hat{p}_i$) of the sinogram data. This criterion is not based upon a region of interest in an *image domain*, as recited in the instant claims. Therefore, contrary to the Examiner's statement, the optimization criterion is limited to an *image domain* and, in fact, this limitation clearly distinguishes the claimed subject matter from De Man.

Since De Man fails to teach or suggest at least the steps of (1) identifying an optimization criterion based upon the region of interest, in an image domain, and (2) iteratively adjusting the measured sinogram elements at least in the trace of the high density object in the measured sinogram data based upon an optimization criterion in the image domain, to generate corrected sinogram data, De Man cannot anticipate independent claims 1, 18, 19, 21, and 22 and the claims depending therefrom. Therefore, Appellant contends that the Examiner has not satisfied the burden of establishing a *prima facie* case of anticipation of these claims by De Man. Thus, it is respectfully requested that the rejection of claims 1, 2, 10-13, 18, 19, 21, and 22 under 35 U.S.C 102(b) be reversed by the Board.

B. **Ground of Rejection No. 2:**

The Examiner rejected claim 7 under 35 U.S.C 103(a) as being unpatentable over De Man in view of Hsieh. Because Hsieh fails to cure the deficiencies of De

Man, Appellant respectfully requests that the Board review and reverse the improper rejection of these claims.

1. **<u>Judicial precedent has clearly established a legal standard for a *prima facie* obviousness rejection.</u>**

The burden of establishing a *prima facie* case of obviousness falls on the Examiner. *Ex parte Wolters and Kuypers*, 214 U.S.P.Q. 735 (PTO Bd. App. 1979). In addressing obviousness determinations under 35 U.S.C. § 103, the Supreme Court in *KSR International Co. v. Teleflex Inc.*, No. 04-1350 (April 30, 2007), reaffirmed many of its precedents relating to obviousness including its holding in *Graham v. John Deere Co.,* 383 U.S. 1 (1966). In *KSR*, the Court also reaffirmed that "a patent composed of several elements is not proved obvious merely by demonstrating that each of its elements was, independently, known in the prior art." *Id.* at 14. In this regard, the *KSR* court stated that "it can be important to identify a reason that would have prompted a person of ordinary skill in the relevant field to combine the elements in the way the claimed new invention does … because inventions in most, if not all, instances rely upon building blocks long since uncovered, and claimed discoveries almost of necessity will be combinations of what, in some sense, is already known." *Id.* at 14-15. In *KSR*, the court noted that the demonstration of a teaching, suggestion, or motivation to combine provides a "helpful insight" in determining whether claimed subject matter is obvious. *KSR, slip op.* at 14.

Furthermore, the *KSR* court did not diminish the requirement for objective evidence of obviousness. *Id.* at 14 ("To facilitate review, this analysis should be made explicit. See *In re Kahn,* 441 F.3d 977, 988 (CA Fed. 2006) ("[R]ejections on obviousness grounds cannot be sustained by mere conclusory statements; instead, there must be some articulated reasoning with some rational underpinning to support the legal conclusion of obviousness"). As our precedents make clear, however, the analysis need not seek out precise teachings directed to the specific subject matter of the challenged claim, for a court can take account of the inferences and creative steps that a person of ordinary skill in the art would employ."); s*ee also, In re Lee,* 61 U.S.P.Q.2d 1430, 1436

(Fed. Cir. 2002) (holding that the factual inquiry whether to combine references must be thorough and searching, and that it must be based on *objective evidence of record*).

When prior art references require a selected combination to render obvious a subsequent invention, there must be some reason for the combination other than the hindsight gained from the invention itself, i.e., something in the prior art as a whole must suggest the desirability, and thus the obviousness, of making the combination. *Uniroyal Inc. v. Rudkin-Wiley Corp.*, 837 F.2d 1044, 5 U.S.P.Q.2d 1434 (Fed. Cir. 1988). One cannot use hindsight reconstruction to pick and choose among isolated disclosures in the prior art to deprecate the claimed invention. *In re Fine*, 837 F.2d 1071, 5 U.S.P.Q.2d 1596 (Fed. Cir. 1988). The Federal Circuit has warned that the Examiner must not, "fall victim to the insidious effect of a hindsight syndrome wherein that which only the inventor taught is used against its teacher." *In re Dembiczak*, F.3d 994, 999, 50 U.S.P.Q.2d 52 (Fed. Cir. 1999) (quoting *W.L. Gore & Assoc., Inc. v. Garlock, Inc.*, 721 F.2d 1540, 1553, 220 U.S.P.Q. 303, 313 (Fed. Cir. 1983)).

It is improper to combine references where the references teach away from their combination. *In re Grasselli*, 713 F.2d 731, 743, 218 U.S.P.Q. 769, 779 (Fed. Cir. 1983); M.P.E.P. § 2145. Moreover, if the proposed modification or combination of the prior art would change the principle of operation of the prior art invention being modified, then the teachings of the references are not sufficient to render the claims *prima facie* obvious. *In re Ratti*, 270 F.2d 810, 123 U.S.P.Q. 349 (CCPA 1959); *see* M.P.E.P. § 2143.01(VI). If the proposed modification or combination would render the prior art invention being modified unsatisfactory for its intended purpose, then there is no suggestion or motivation to make the proposed modification. *In re Gordon*, 733 F.2d 900, 221 U.S.P.Q. 1125 (Fed. Cir. 1984); *see* M.P.E.P. § 2143.01(V).

2. **The Examiner's rejection of claim 7 is improper because the rejection fails to establish a *prima facie* case of obviousness.**

Appellant respectfully notes that claim 7 depends from independent claim 1. As discussed above, De Man fails to disclose each and every element of this independent claim. Further, Appellant respectfully submits that Hsieh does not cure the deficiencies described above with respect to De Man. Specifically, Hsieh does not disclose the steps of (1) identifying an optimization criterion based upon the region of interest, in an image domain and (2) iteratively adjusting the measured sinogram elements at least in the trace of the high density object in the measured sinogram data based upon an optimization criterion in the image domain, to generate corrected sinogram data. For at least this reason, Appellant respectfully asserts that the Examiner has clearly not established a *prima facie* case of obviousness with respect to dependent claim 7. Accordingly, Appellant respectfully requests that the Board reverse the improper rejection of claim 7 under 35 U.S.C § 103(a).

C. **Ground of Rejection No. 3:**

The Examiner rejected claim 8 under 35 U.S.C. 103(a) as being unpatentable over De Man in view of Luo. Because Luo fails to cure the deficiencies of De Man, Appellant respectfully requests that the Board review and reverse the improper rejection of these claims.

1. **The Examiner's rejection of claim 8 is improper because the rejection fails to establish a *prima facie* case of obviousness.**

Appellant respectfully notes that claim 8 depends from independent claim 1. As discussed above, De Man fails to disclose each and every element of this independent claim. Further, Appellant respectfully submits that Luo does not cure the deficiencies described above with respect to De Man. Specifically, Luo does not disclose the steps of (1) identifying an optimization criterion based upon the region of interest, in an image domain and (2) iteratively adjusting the measured sinogram elements at least in the trace of the high density object in the measured sinogram data

based upon an optimization criterion in the image domain, to generate corrected sinogram data. For at least this reason, Appellant respectfully asserts that the Examiner has clearly not established a *prima facie* case of obviousness with respect to dependent claim 8. Accordingly, Appellant respectfully requests that the Board reverse the improper rejection of claim 8 under 35 U.S.C § 103(a).

D. **Ground of Rejection No. 4:**

The Examiner rejected claim 9 under 35 U.S.C. 103(a) as being unpatentable over De Man in view of Karimi. Because Karimi fails to cure the deficiencies of De Man, Appellant respectfully requests that the Board review and reverse the improper rejection of these claims.

1. **The Examiner's rejection of claim 9 is improper because the rejection fails to establish a *prima facie* case of obviousness.**

Appellant respectfully notes that claim 9 depends from independent claim 1. As discussed above, De Man fails to disclose each and every element of this independent claim. Further, Appellant respectfully submits that Karimi does not cure the deficiencies described above with respect to De Man. Specifically, Karimi does not disclose the steps of (1) identifying an optimization criterion based upon the region of interest, in an image domain and (2) iteratively adjusting the measured sinogram elements at least in the trace of the high density object in the measured sinogram data based upon an optimization criterion in the image domain, to generate corrected sinogram data. For at least this reason, Appellant respectfully asserts that the Examiner has clearly not established a *prima facie* case of obviousness with respect to dependent claim 9. Accordingly, Appellant respectfully requests that the Board reverse the improper rejection of claim 9 under 35 U.S.C § 103(a).

Conclusion

Appellant respectfully submits that all pending claims are in condition for allowance. However, if the Examiner or Board wishes to resolve any other issues by way of a telephone conference, the Examiner or Board is kindly invited to contact the undersigned attorney at the telephone number indicated below.

Respectfully submitted,

Date: April 23, 2008

/Patrick S. Yoder/

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8. APPENDIX OF CLAIMS ON APPEAL

Listing of Claims:

1. A method for reducing artifacts in image data generated by a computed tomography system, the artifacts being due to the presence of a high density object in a subject of interest, the method comprising:

receiving measured sinogram data from the computed tomography system, the sinogram data representative of a plurality of measured sinogram elements;

reconstructing the measured sinogram data to generate initial reconstructed image data;

identifying a trace of the high density object in the measured sinogram data;

identifying a region of interest in the initial reconstructed image data;

identifying an optimization criterion based upon the region of interest, in an image domain;

iteratively adjusting the measured sinogram elements at least in the trace of the high density object in the measured sinogram data based upon the optimization criterion in the image domain, to generate corrected sinogram data; and

reconstructing the corrected sinogram data to generate improved reconstructed image data.

2. The method of claim 1, wherein the initial reconstructed image data is generated using a filtered back projection technique.

7. The method of claim 1, wherein identifying a region of interest is based on an attenuation value associated with the region of interest.

8. The method of claim 1, wherein identifying a region of interest is based on a uniformity value associated with the region of interest.

9. The method of claim 1, wherein identifying a region of interest is based on the relative position of the region of interest with respect to the high density object.

10. The method of claim 1, wherein the optimization criterion comprises determining an optimal attenuation value associated with the region of interest.

11. The method of claim 1, wherein the optimization criterion comprises determining an optimal uniformity value associated with the region of interest.

12. The method of claim 1, wherein the optimization criterion comprises minimizing angular variations associated with the region of interest based on the relative position of the region of interest with respect to the high density object.

13. The method of claim 1, wherein reconstructing the corrected sinogram data to generate improved reconstructed image data comprises using a filtered back projection technique.

18. A computed tomography system for reducing artifacts in image data, the artifacts being due to the presence of a high density object in a subject of interest, the system comprising:

an x-ray source configured to project an x-ray beam from a plurality of positions through the subject of interest;

a detector configured to produce a plurality of electrical signals corresponding to the x-ray beam; and

a processor configured to process the plurality of electrical signals to generate measured sinogram data, the sinogram data representative of a plurality of measured sinogram elements, wherein the processor is further configured to reconstruct the measured sinogram data to generate initial reconstructed image data; identify a trace of the high density object in the measured sinogram data; identify a region of interest in the initial reconstructed image data; identify an optimization criterion based upon the region of

interest, in an image domain; iteratively adjust the measured sinogram elements at least in the trace of the high density object in the measured sinogram based upon the optimization criterion in the image domain, to generate corrected sinogram data; and reconstruct the corrected sinogram data to generate improved reconstructed image data.

19. At least one computer-readable medium storing computer instructions for instructing a computer system to reduce artifacts in image data generated by a computed tomography system, the artifacts being due to the presence of a high density object in a subject of interest, the computer instructions comprising:

receiving measured sinogram data from the computed tomography system, the sinogram data representative of a plurality of measured sinogram elements;

reconstructing the measured sinogram data to generate initial reconstructed image data;

identifying a trace of the high density object in the measured sinogram data;

identifying a region of interest in the initial reconstructed image data;

identifying an optimization criterion based upon the region of interest, in an image domain;

iteratively adjusting the measured sinogram elements at least in the trace of the high density object in the measured sinogram data based upon the optimization criterion in the image domain, to generate corrected sinogram data; and

reconstructing the corrected sinogram data to generate improved reconstructed image data.

21. A computed tomography system for reducing artifacts in image data, the artifacts being due to the presence of a high density object in a subject of interest, the system comprising:

means for processing a plurality of electrical signals corresponding to an x-ray beam generated by the computed tomography system to generate measured sinogram data, the sinogram data representative of a plurality of measured sinogram elements, wherein the processing further comprises reconstructing the measured sinogram data to

generate initial reconstructed image data; identify a trace of the high density object in the measured sinogram data; identify a region of interest in the initial reconstructed image data; identify an optimization criterion based upon the region of interest, in an image domain; iteratively adjust the measured sinogram elements at least in the trace of the high density object in the measured sinogram data based upon the optimization criterion in the image domain, to generate corrected sinogram data; and reconstruct the corrected sinogram data to generate improved reconstructed image data.

22. A method for reducing artifacts in image data generated by a computed tomography system, the artifacts being due to the presence of objects in a subject of interest, the method comprising:

receiving measured sinogram data from the computed tomography system, the sinogram data representative of a plurality of measured sinogram elements;

reconstructing the measured sinogram data to generate initial reconstructed image data;

identifying a sinogram region of interest in the measured sinogram data;

identifying an image region of interest in the initial reconstructed image data;

identifying an optimization criterion based upon the image region of interest, in an image domain;

iteratively adjusting the measured sinogram elements in at least the sinogram region of interest based upon the optimization criterion in the image domain, to generate corrected sinogram data; and

reconstructing the corrected sinogram data to generate improved reconstructed image data.

9. **EVIDENCE APPENDIX**

For the convenience of the Board, Appellant has attached a copy of an affidavit submitted by Bruno Kristiaan Bernard De Man on December 26, 2007, which attests to the distinctions between his previous work and the claimed subject matter in the present application.

10. **RELATED PROCEEDINGS APPENDIX**

None.